Work Assignment No. 6
MTA Agreement No. 15099-0300

Utica Avenue Transit Improvements Study

Task 2 Deliverable 3: Crown Heights-Utica Av Station

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Prepared for:

MTA New York City Transit

Submitted by:

WSP

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1 Executive Summary

Crown Heights-Utica Av Station (hereafter, Utica Av Station) is the southern[1] terminal for the 4 (at all times except overnight hours) and a through station for the 3, which continues to New Lots Av Terminal (at all times except overnight hours).[2] As a result of these service patterns, Utica Av Station must be capable of efficiently turning back and reversing 4 trains while simultaneously enabling through 3 trains to serve the station without delaying either service.

Utica Av Station has a pair of stacked center island platforms, with the upper level platform serving subway southbound trains (to New Lots or terminating) and the lower level platform serving subway northbound trains (to Manhattan). On both levels, the 3 generally uses the geographical south side of the platform and the 4 generally uses the geographical north side of the platform. (Platform use varies during the overnight period and when there are service changes due to planned work.) This arrangement keeps both services separate and helps reduce potential train operational conflicts.

At both the subway north and subway south ends of the station, turnouts and crossovers enable trains in both directions to access the required tracks in and beyond the station. Subway southbound 4 trains that reverse (change directions) at Utica Av Station do so on the two tail tracks located subway south of the station. Reversing trains on tail tracks beyond a station is called a relay operation, and if the trains being reversed are relayed quickly and efficiently, they do not interfere with other in-service trains (e.g., 3 through trains or subsequent 4 trains seeking to reverse at Utica Av Station).

The primary operating issue at the existing Utica Av Station is that arriving subway southbound trains can, at times, overwhelm the relay operation, which results in subsequent southbound trains being held subway north of Utica Av Station while they wait their turn to enter the station, discharge customers, and leave the station to relay on one of the two tail tracks. A secondary issue is trainset storage in Brooklyn to accommodate the expanding subway fleet.

Since Utica Av Station is in a dense urban neighborhood, as well as under historic, landmarked Eastern Parkway, any large-scale construction to provide additional relay/storage tracks could be highly disruptive to the community and potentially cost prohibitive. Therefore, this report proposes a targeted set of improvements that seeks to minimize community impacts and costs and manage potential impacts to subway operations during construction.

This report evaluates two improvements for increasing operational flexibility (by installing new crossovers to improve track access) and three improvements to increase both relay and train storage capacity.[3]

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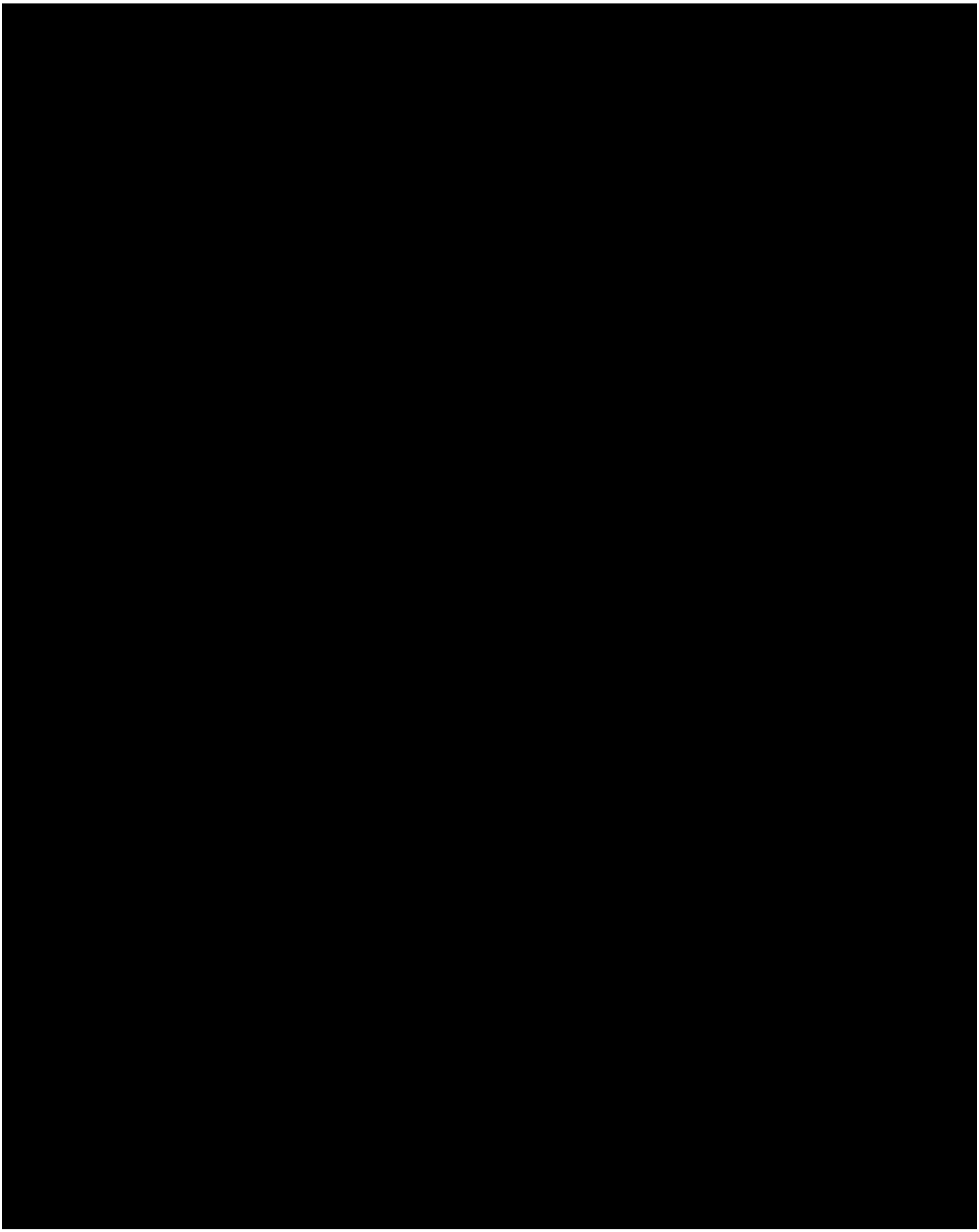
[1] This report uses the NYCT convention of naming the direction of subway service on the Eastern Parkway Line as either subway northbound for a track where the primary direction of service is towards Manhattan or subway southbound for a track where the primary direction of service is away from Manhattan. The orientations and relative locations of all elements of subway infrastructure are named according to the local application of the subway north and subway south convention and not according to actual geography.

[2] Additionally, some 5 trains terminate with the 4 during rush hours, and some 2, 4, and 5 trains operate through to New Lots Av Terminal as well.

[3] The naming conventions "Improvement C__" and "Improvement TS__" refer to improvements associated with a crossover and train storage, respectively. The prefixes are used to enable functional grouping of improvements.



As a subsequent step in this study, the Study Team will determine—in coordination with NYCT and the Steering Committee—whether some or all of the recommendations contained herein should be included in the Final Investment Packages in Task 5 (including consideration for transit improvements along Utica Ave). Regardless of whether the improvements are included in the Final Investment Packages, they still have independent utility and can be advanced by NYCT beyond this study. It should also be noted that the formal evaluation of potential environmental impacts at the A-Division improvement locations would need to be the subject of work beyond the scope of this study.

If any of the improvements identified in this report are advanced beyond this study, the concepts would need to be revisited in a subsequent design phase, including the basis of estimate for capital cost and construction duration as well as the conservative assumption of a design-bid-build contracting method.[6]

2 Introduction

This report, developed as part of the Utica Avenue Transit Improvements Study (hereafter, Utica Avenue Study), recommends possible infrastructure improvements at Crown Heights-Utica Av Station (hereafter, Utica Av Station). Utica Av Station serves as both as a through and terminal station. As such, it must be capable of handling two different types of subway operations, efficiently turning back and reversing trains while simultaneously enabling through trains to serve the station.

This is one of the five stand-alone locations identified in the Utica Avenue Study Scope of Work where operational and capacity improvements could be made to the existing subway system, complementary to but independent of any potential transit improvements along the Utica Avenue corridor. The intent of studying the five locations is to identify methods to increase the A-Division train service capacity and operational flexibility in eastern Brooklyn and offer a range of solutions to alleviate existing constrained conditions pertaining to train operation bottlenecks and shortage of train storage or lay-up capability. The other four stand-alone locations are Nostrand Junction, Flatbush Av Terminal, New Lots Av Terminal, and Livonia and Linden Yards.

Figure 1 shows the five improvement locations in the context of the Utica Avenue Study Area.

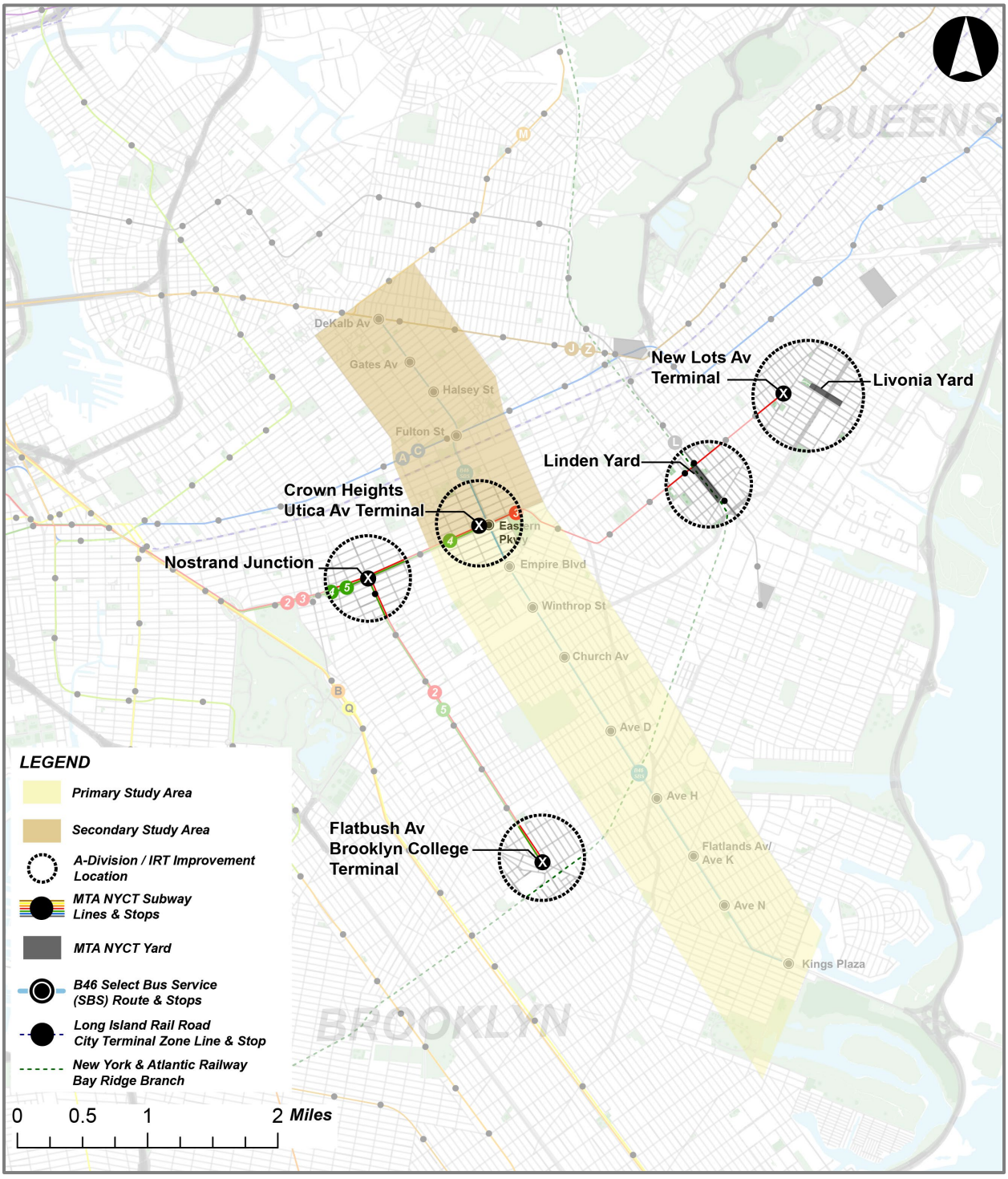
The infrastructure improvements discussed in this report would address operational constraints associated with trains arriving, departing, and operating through Utica Av Station, as well as limited train storage. This report identifies two operational improvement categories:

1. Addition of crossovers to improve operational flexibility.

2. Addition/extension of tracks to increase train storage.

Overall, this deliverable for the Utica Avenue Study addresses prospective changes at Utica Av Station that would enhance the operational flexibility and increase train storage capacity.

Figure 1: Study Area and A-Division Improvement Locations for the Utica Avenue Transit Improvements Study



Source: WSP, 2020

3 Existing Conditions and Constraints

Utica Av Station is primarily served by the 3 and 4. During the day, it is the terminus for the 4 and serves as a mid-line stop for the 3, which continues onto the New Lots Av Line beyond Utica Av Station, terminating at New Lots Av Station. A reduced subway service is in effect during late night hours (Midnight – 6 AM, daily) with only local 4 service to Utica Av Station, continuing to New Lots Av Terminal (replacing the 3, which only runs in Manhattan). During rush hours, a small number of 5 trains also terminate at Utica Av Station, due to limited terminal capacity at Flatbush Av Terminal. In addition, some 2, 4, and 5 trains operate through Utica Av Station to be stored at Livonia Yard, which is subway south of New Lots Av Terminal.

3.1 EXISTING INFRASTRUCTURE

Utica Av Station is an underground station on NYCT's A-Division Eastern Parkway Line, located beneath Eastern Parkway between Schenectady and Utica Avenues in the Crown Heights neighborhood of eastern Brooklyn. The Utica Av Station structure runs geographically east-west under Eastern Parkway and has two entrances, one at Schenectady Avenue at the east end and one at Utica Avenue at the west end. Both entrances have staircases on the north and south sides of Eastern Parkway, located in the wide pedestrian malls that parallel the roadway. The staircases lead to a non-continuous "split mezzanine" located just below the street level, which contains the fare control area. There is one mezzanine under Utica Avenue and another under Schenectady Avenue, and the mezzanines are not connected to each other. Only the Utica Avenue end is staffed. The station is Americans with Disabilities Act (ADA) accessible, with one elevator to the street located at the northwest corner of the Utica Avenue and Eastern Parkway intersection. A second elevator, within the fare control area, provides access from the mezzanine to the platform levels below.

Utica Av Station has a pair of stacked center island platforms, with the upper level platform serving subway southbound[7] trains (to New Lots or terminating) and the lower level platform serving subway northbound trains (to Manhattan). On both levels, the 3 generally uses the geographical south side of the platform and the 4 generally uses the geographical north side of the platform (platform use varies during the overnight period and when there are service changes due to planned work). This arrangement keeps both services separate and helps reduce potential train operational conflicts.

This station has a stacked platform configuration below the mezzanine level, with an upper island platform level located above a lower island platform level. Beyond the geographical east end of Utica Av Station, the Eastern Parkway Line tracks for the 3 continue subway south to the New Lots Line. Also beyond the geographical east end of the station there are two tail tracks used to reverse the direction of travel of 4 trains back to Manhattan and the Bronx. Bus connections are available to the B46 and B46 Select Bus Service (SBS) on Utica Avenue, and to the B14 and B17 on Eastern Parkway.

[7] This report uses the NYCT convention of naming the direction of subway service on the Eastern Parkway Line as either subway northbound for a track where the primary direction of service is towards Manhattan or subway southbound for a track where the primary direction of service is away from Manhattan. The orientations and relative locations of all elements of subway infrastructure are named according to the local application of the subway north and subway south convention and not according to actual geography.

Approximately two blocks compass east of the station, the Eastern Parkway Line tracks curve compass south to parallel Portal Street and transition from tunnel onto an elevated structure, where they are re-designated as the New Lots Line.

Figure 2 is an aerial photograph of the area surrounding Utica Av Station, marked-up to show the location of the underground station under Eastern Parkway, the underground tracks geographically east of the station, the tunnel portal, and the New Lots Line transitioning onto an elevated structure.

Figure 3 shows a schematic of the track configuration at Utica Av Station. Tracks E1 and E2 on the upper level serve the southbound local and express services, respectively. Tracks E3 and E4 on the lower level serve the northbound express and local service, respectively. Compass east of the station, a set of crossovers and ramps allow trains to connect between different tracks on different levels.

On the upper level, a #10 diamond crossover allows trains to switch between Tracks E1and E2 and vice versa. On the lower level, a #5 equilateral ("Y" shaped) turnout located below the #10 diamond crossover on the upper level, connects Tracks E3 and E4 to Track EM, which then ramps up to between Tracks E1 and E2 on the upper level, subway south of the #10 diamond crossover. Further subway south, a second #10 diamond crossover on the upper level connects Tracks EM and E2 and a #8 universal crossover connects Tracks EM and E1. Track E1 continues to daylight at the tunnel portal as the New Lots Line southbound track. Track EM continues to daylight at the tunnel portal as a New Lots Line center track that terminates approximately 540 feet beyond the portal. Track E2 continues under Eastern Parkway for about 600 feet to a tunnel bulkhead.

On the lower level, Track E3 continues under Eastern Parkway for about 1,400 feet beyond the connection to Track EM to a tunnel bulkhead. Track E4 continues beyond the connection to Track EM to daylight at the tunnel portal as the New Lots Line northbound track. Figure 4 shows a cross-section of the tunnel structure at the #10 diamond crossover between Tracks E1 and E2 on the upper level with Tracks E4, EM, and E3 on the lower level.

Continuing subway south, at the approximate location of Buffalo Avenue, the tunnel structure bifurcates on both levels, as shown in Figure 5. Tracks E1 and EM on the upper level and Track E4 on the lower level begin to curve towards the New Lots Line. As upper level Tracks E1 and EM split from Track E2, an empty track bay in between the bifurcation is developed. This empty track bay, named by the Utica Avenue Study Team "Track E2M," is an existing unused bay that was built for an unrealized extension of the Eastern Parkway Line, and since this line was never built, this bay was never filled with a track. It runs parallel to Track E2 and extends straight for approximately 250 feet from the point where Track EM starts to curve toward the tunnel portal. Track E2, as well as Track E3 on the lower level, continue under Eastern Parkway until terminating at the tunnel structure bulkhead.

Figure 6 shows Tracks E1 (southbound), EM, and E4 (northbound) after they daylight at the tunnel portal. The center track, Track EM subway south of the tunnel portal, is not in a state of good repair.

Figure 6: View of Tracks E4, EM, and E1 (from left to right, looking Subway South) in Open Cut as Seen from above the Tunnel Portal

Source: WSP, 2019

3.2 EXISTING OPERATIONS

When the 4 terminates at Utica Av Station, trains arrive at Track E2 on the upper level of the station and discharge passengers at the southbound station platform. At this point the southbound train is out of revenue service, and the train operator's cab is deactivated (i.e., master controller disengaged, train parking brakes activated, etc.), beginning the relay process. The mainline train operator and conductor (also called the road crew) swap crews on the platform for the relay train operator and conductor; that crew waits in a small enclosed area near the front car on the southbound platform for incoming southbound trains. During this process, NYCT staff walk through the train to ensure that no passengers remain onboard.

After the train operator's cab is activated by the relay crew, the train continues subway south to one of the two tail tracks, specifically either Track E2 or Track EM using the #10 diamond crossover from Track E2. Once clear of the crossover, the train operator stops the train, secures the brakes, exits the cab, and walks to the other end of the train, where the cab in the rear car is activated to become the front car in the subway northbound direction. During peak periods, 4 service operates 12-13 trains per hour, which implies a relay time of 10 minutes or less per train.

When ready to begin the northbound journey (to Manhattan and the Bronx) and after the signals clear, the train operates subway northbound along Track EM, which ramps down to the lower level of the station, uses the #5 equilateral turnout to access Track E3 and enters the northbound station platform to pick up customers. The relay train crew departs, with the road crew taking over. At this point the train is in service for the northbound trip. The relay crew then heads upstairs to await the next train. Several relay staff are required to be on duty to handle the arriving 4 trains.

3.3 EXISTING OPERATIONAL CONSTRAINTS

The ability of the 4 to relay at Utica Av Station is constrained by lack of layup capacity. Tracks E2 and EM must be used to relay all 4 trains terminating at Utica Av Station. As noted in the previous section, there is currently a relay time of 10 minutes or less per train during peak periods, when 4 service operates 12-13 trains per hour. When Communications-Based Train Control (CBTC) is installed (see Section 4.2), service frequencies are likely to increase. This would put more pressure on the relay operation and possibly require an increase in relay capacity.

Track E3 can accommodate two stored trains, but using this track for layup in a relay operation is awkward because it requires a minimum of two reverse movements due to the configuration of the tracks and a lack of direct connections from other tracks. While Track E3 is not conducive for relaying trains, this track does have value as a pocket track that can accommodate a "gap train"[8] to be inserted into revenue service in the event of another train being unavailable, or this track can serve as a staging area for "put-ins," and as an overnight train storage track.

Nearly all 4 trains are stored in the Bronx (at Jerome Yard and Concourse Yard in the instance of the 4 fleet), with a limited number of trains[9] stored at Livonia Yard. Once these trains arrive at Utica Av Station, they must spend non-revenue travel time to relay, so that they can reverse direction from the upper level (southbound) tracks to the lower level (northbound) tracks, before entering service. A secondary issue is the potential need for more trainset storage in Brooklyn to accommodate the expanding subway fleet.

Tracks E2 and EM can accommodate one train each and the configuration of these two tracks is suited to host relay operations. However, when either track hosts relay operations, it cannot be used to concurrently store a train. Overnight, when the 4 runs through to New Lots Av and the relay process is not used, these tracks can each store one trainset.

Finally, lack of crossovers between certain tracks south and north of Utica Av Station reduces operational flexibility and the ability to recover more quickly when there are perturbed operations (e.g., a disabled train, sick passenger, police activity, etc.) on one of the platform tracks.

[8] Appendix A contains a glossary of terms.
[9] Current timetables indicate that three trains assigned to the 4 are stored overnight at Livonia.

4 No Build Conditions for Utica Av Station

4.1 SITE-SPECIFIC CHANGES

Absent this study, no site-specific changes at Utica Av Station are planned, programmed, or committed through the 2035 horizon year.[10] Thus, the existing Utica Av Station plus the addition of CBTC, as discussed below, constitutes the No Build condition at this location.

4.2 COMMUNICATIONS-BASED TRAIN CONTROL

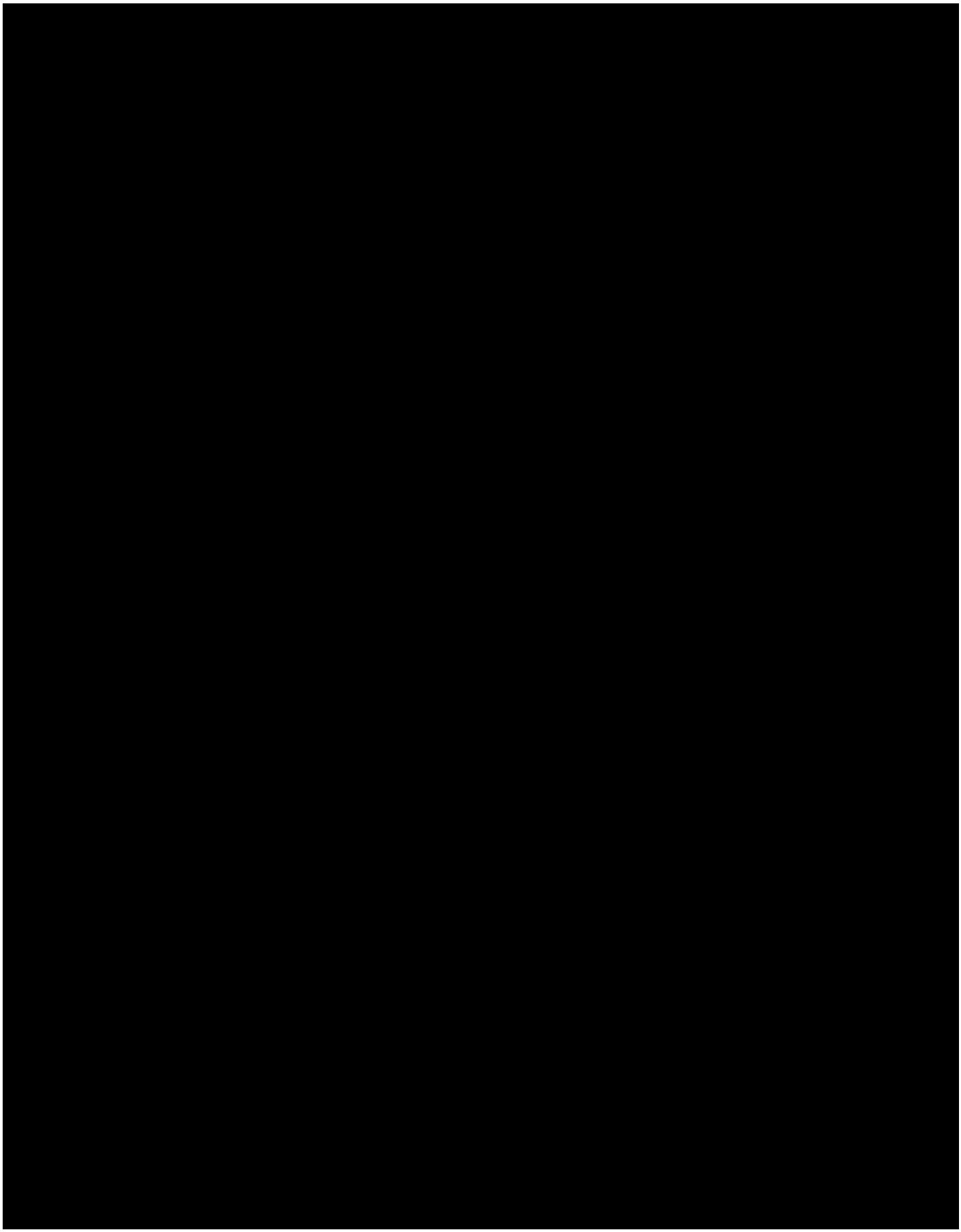
Fast Forward: The Plan to Modernize New York City Transit (Fast Forward Plan) is a 10-year look ahead plan that sets forth a vision to reimagine the subway system. A key element of the plan is the installation of CBTC signaling, which has been proposed to replace segments of the existing fixed-block signaling system. CBTC is considered more reliable than fixed-block signaling, offers train dispatchers more accurate train location information, and has the potential to increase the number of trains running on each line.

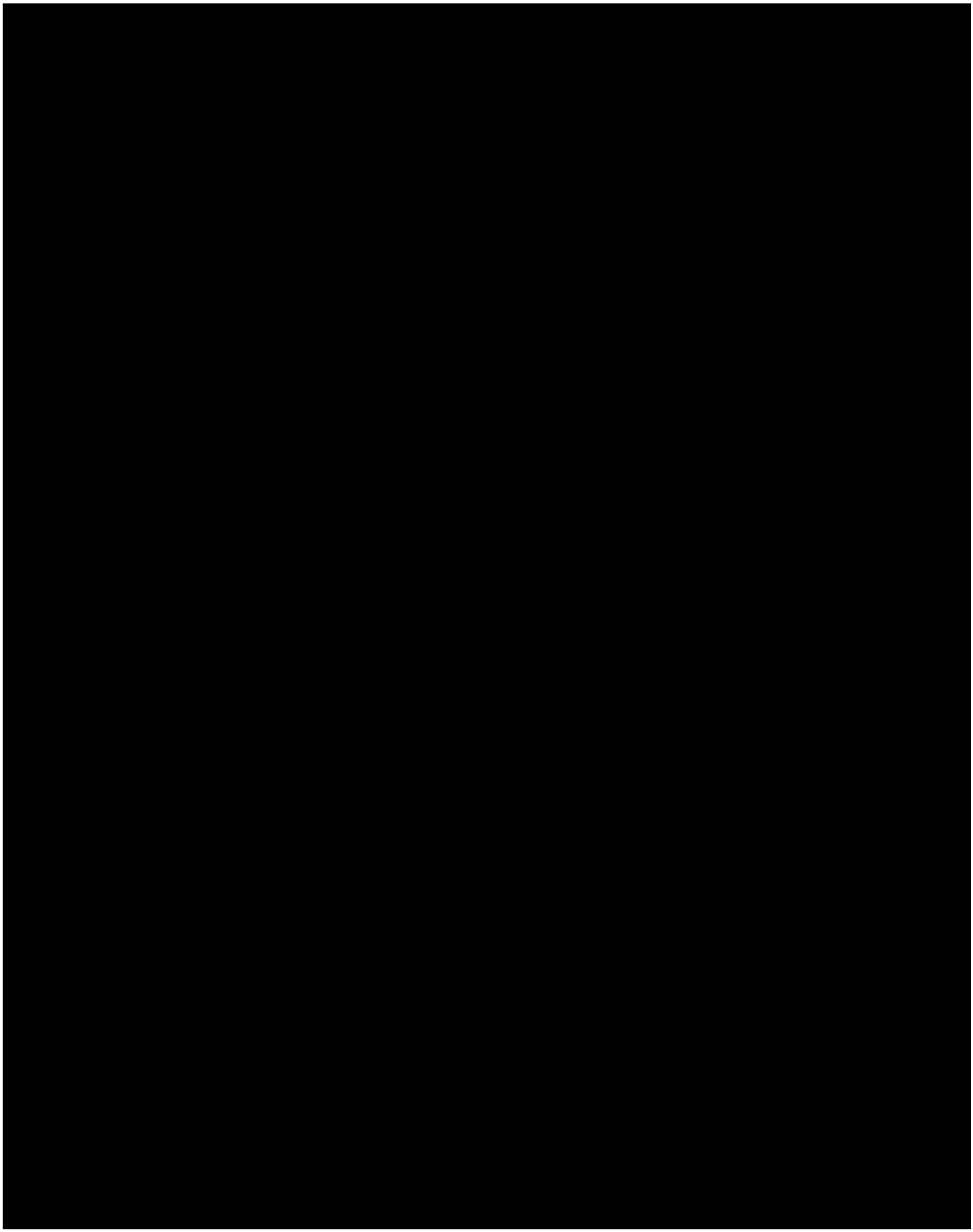
The Fast Forward Plan does not propose to install CBTC on the A-Division Lines east of Nevins Street Station in the first 10 years of plan implementation. However, the NYCT A-Division Capacity Study includes train operations simulation analyses with CBTC installed and active throughout the Brooklyn A-Division Lines. Furthermore, NYCT has directed that the service plans and simulations to be performed as part of the Utica Avenue Study should use the A-Division Capacity Study simulation models with CBTC as a basis for evaluation of the Utica Avenue Study improvements packages. As such, the Utica Avenue Study is proceeding with CBTC as part of the No Build condition.

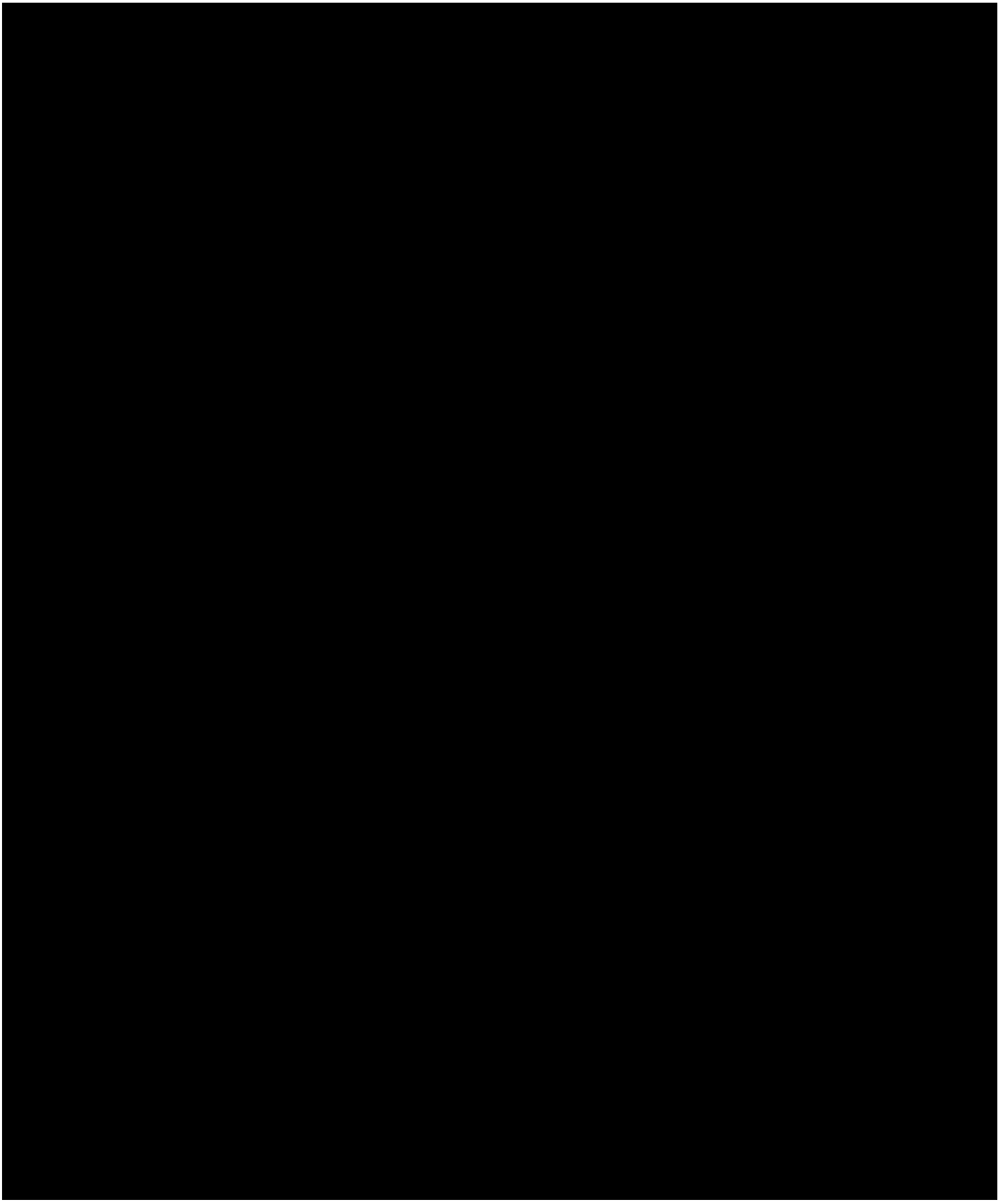
[10] The *MTA Twenty-Year Capital Needs Assessment 2015-2034* identifies the following strategy to "alleviate hotspots," but no improvements are planned, programmed, or committed: "Rebuilding critical subway junctions where lines merge and separate (such as Nostrand Junction on the 2 3 4 5 lines) to maximize train throughput and reduce delays."

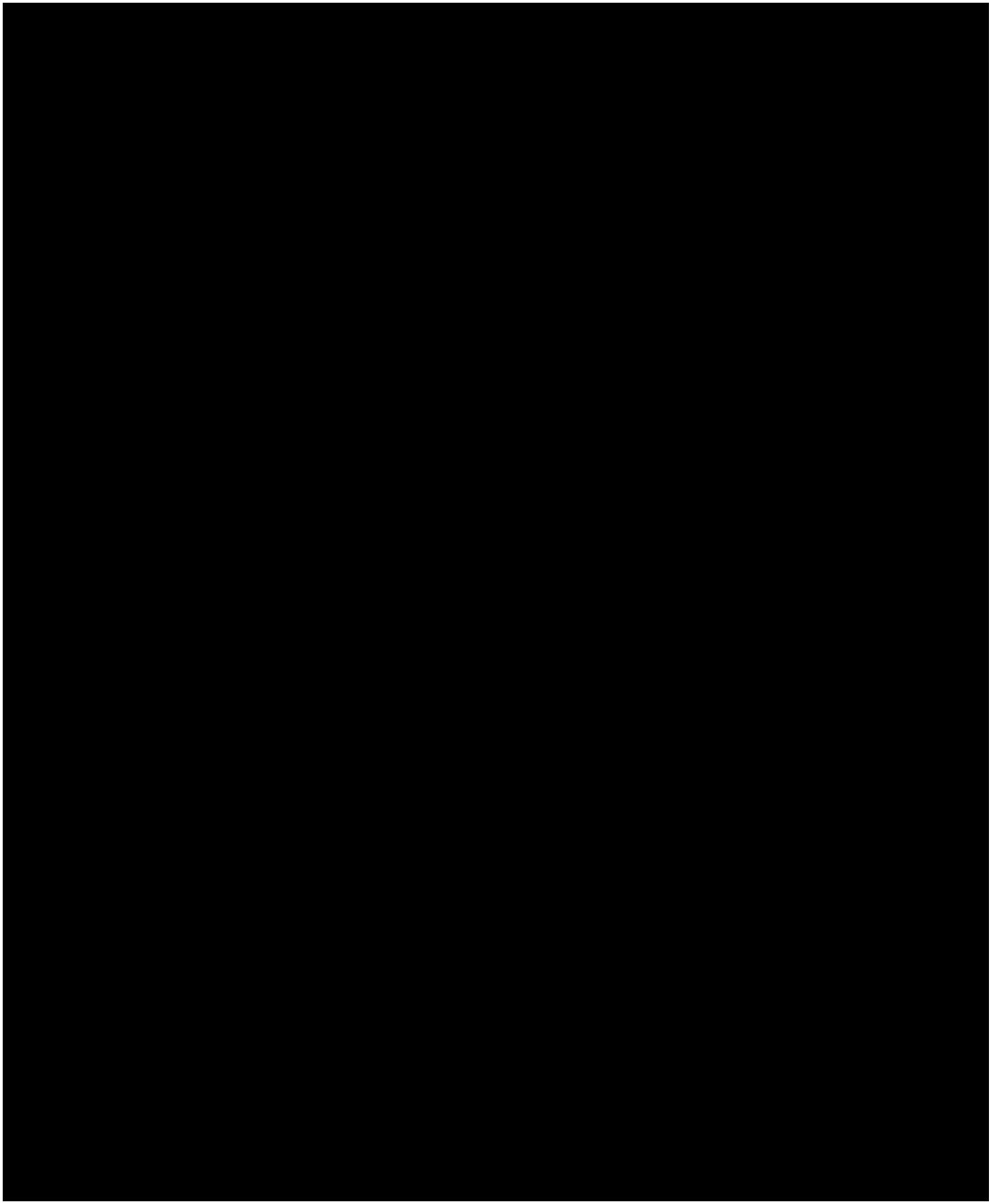
5 Proposed Improvements

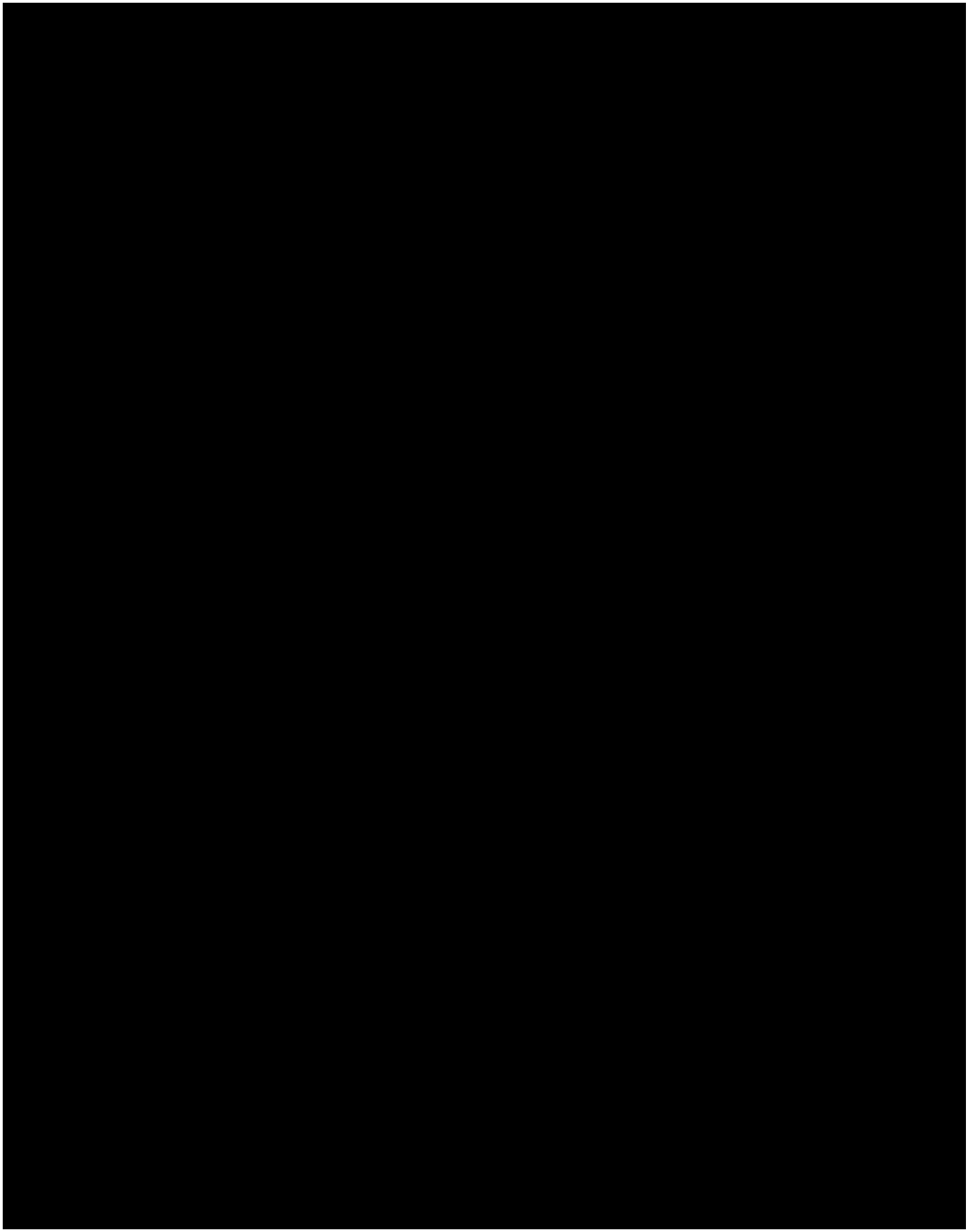
[11] The naming convention "Improvement C__" refers to an improvement associated with a crossover. The prefix is used to enable functional grouping of improvements.

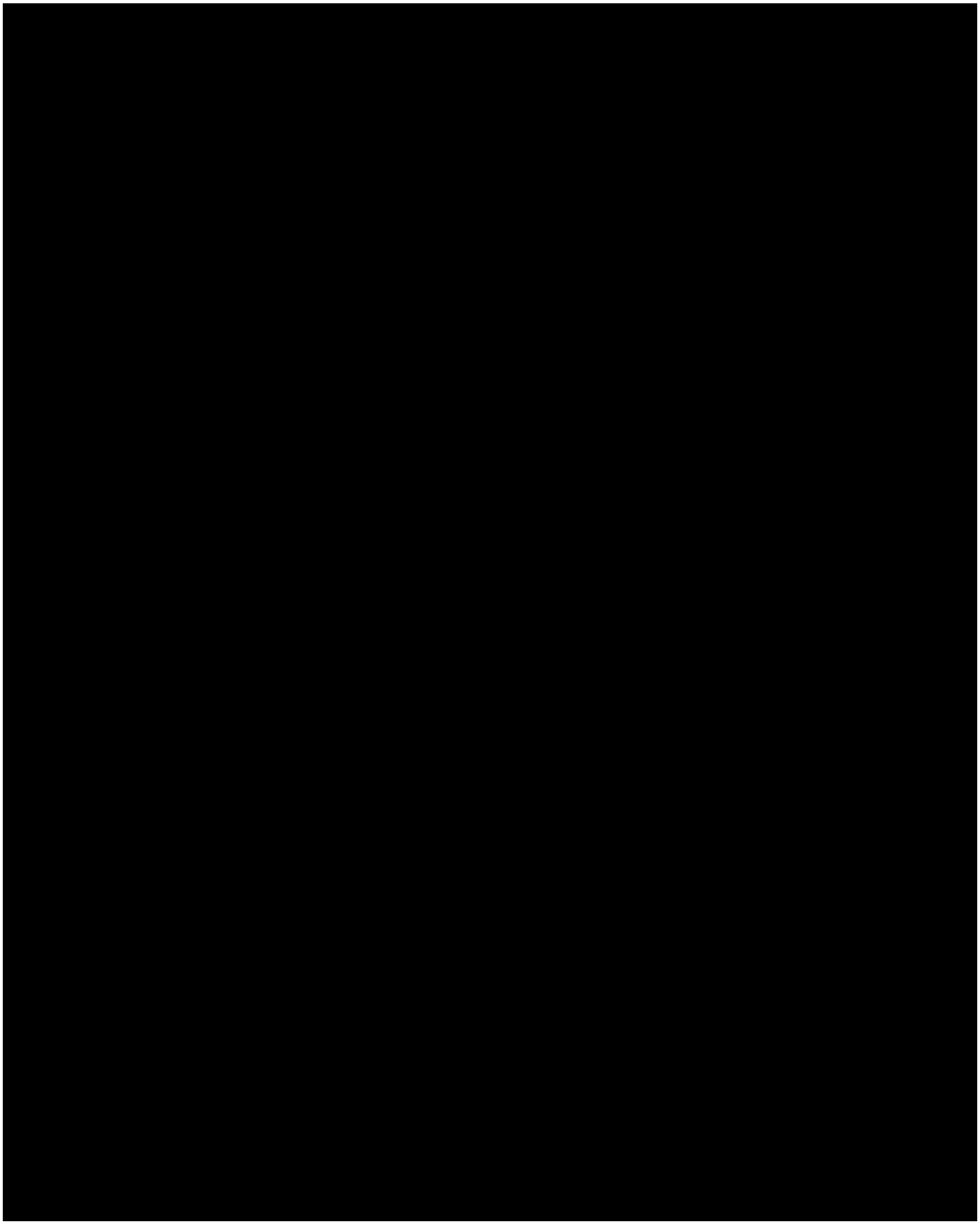


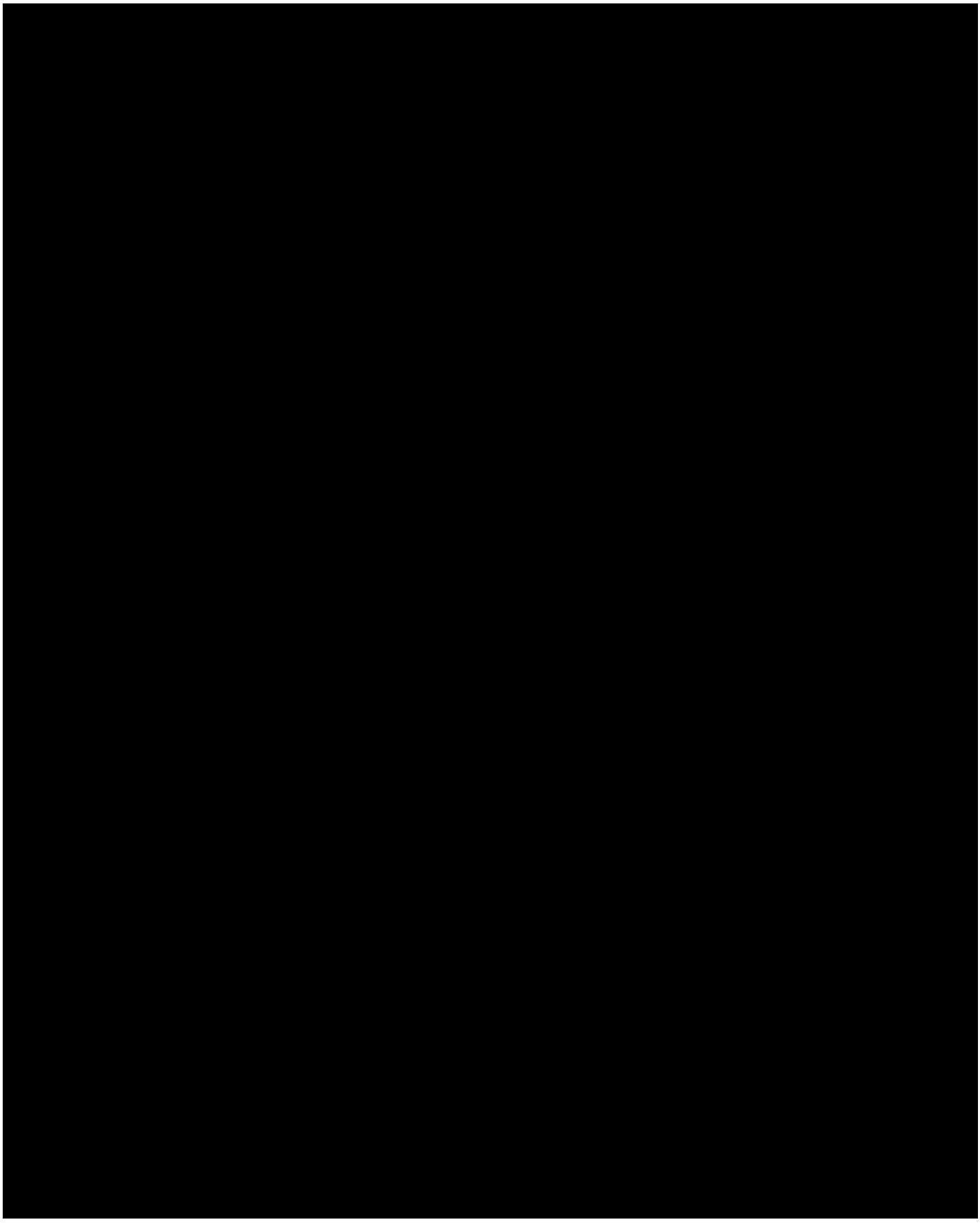




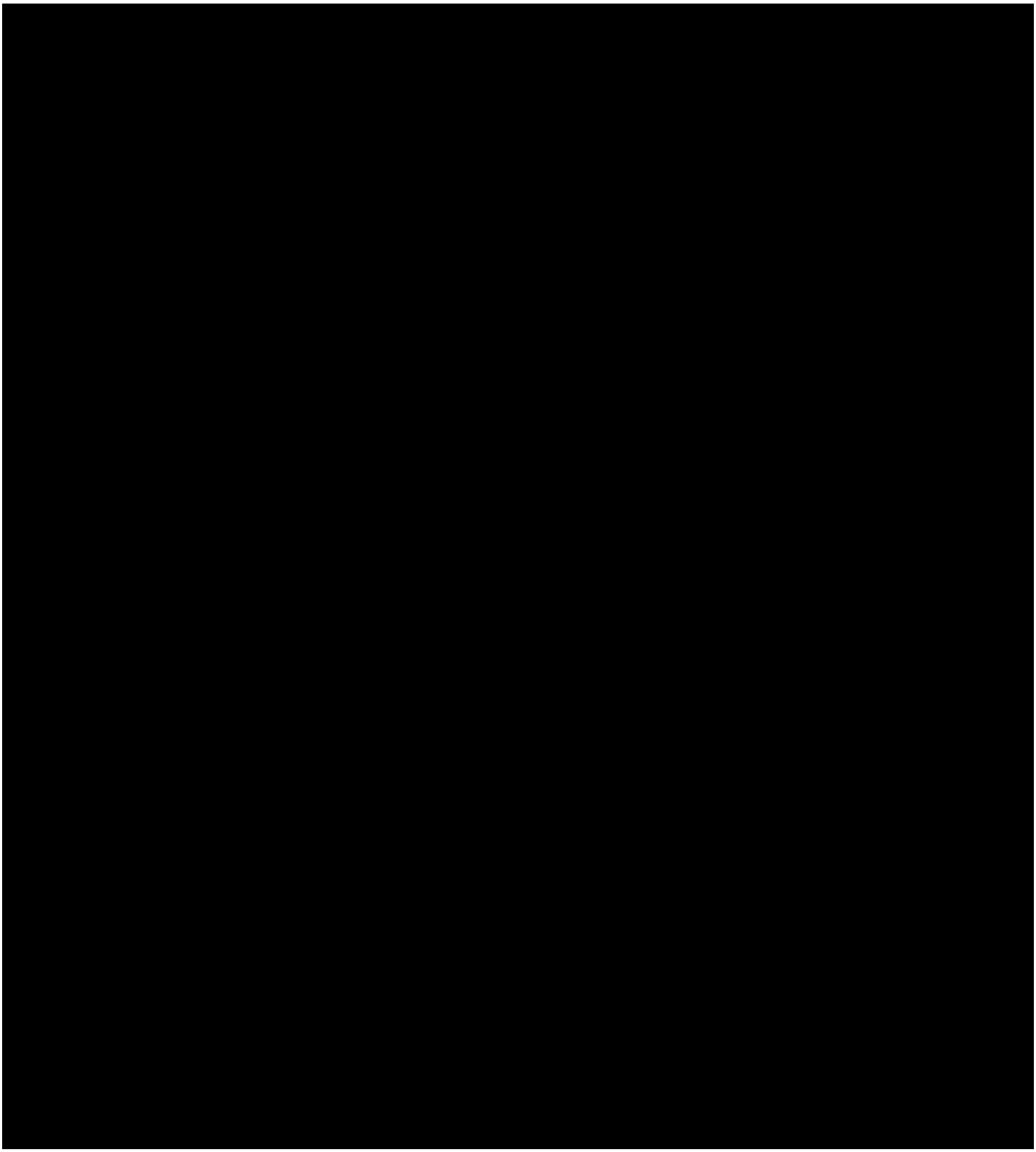


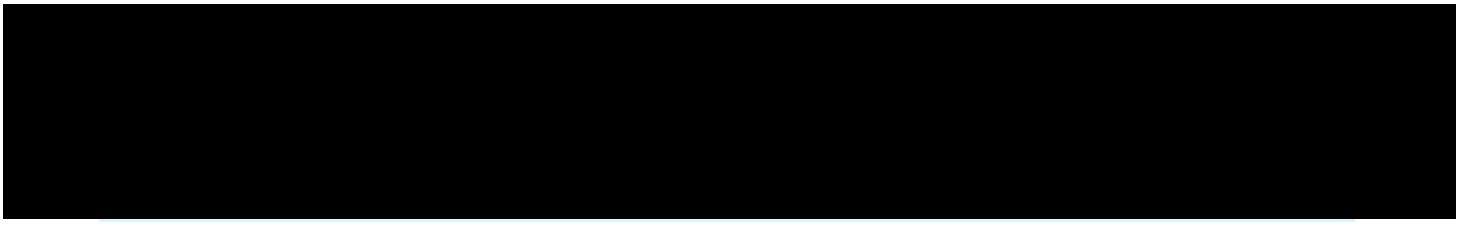






6 Preferred Option Recommendation





7 Conclusion

Utica Av Station is a busy station, serving customers entering the subway from the street, including those transferring from connecting bus service, as well as those transferring to and from the New Lots Line. Operating as both a through and terminal station, it must manage through local trains, all while terminating, relaying, and dispatching express trains that originate from this station without incurring delays to either service. The existing track layout allows these operations to be separated but has constraints in that some relay and storage tracks can be difficult to access which can impede revenue service. In the event of delays at this station, the existing track configuration can become strained very quickly. The recommended improvements would enable this station to diffuse impediments to operations.

The recommended improvements could be implemented individually, in packages, or all at once—depending upon NYCT resources, funding availability and other factors, such as combining implementation with other major work to minimize subway service impacts. Implementation of any of these recommended improvements would be beneficial for subway operations, fluidity and service resiliency.[17]

[17] The A-Division Capacity Study has shown that terminal capacity at Utica Ave Station will be adequate with implementation of CBTC (i.e., the No Build condition). Nevertheless, the infrastructure improvements recommended in this report could provide additional train capacity for increased service levels following implementation of CBTC. As discussed in a separate Utica Ave Study Task 2 deliverable on "Network Modeling of A-Division Improvements" (dated March 2020), operating scenarios that incorporate Improvement C1 from this report were evaluated as an alternative to crossover improvements at Nostrand Junction (i.e., as an alternative to Nostrand Junction Alternative 4).

Appendix A – Glossary of Terms

A-Division comprises the original subway lines constructed by the Interborough Rapid Transit Company. A-Division train cars are narrower than those on the B-Division/BMT-IND lines, but both divisions have the same track gauge (standard, 4'8.5").

Bumper Block is a train stopping device installed on or near the end of a track to prevent trains from traveling beyond that point.

Communications-Based Train Control (CBTC) is a signaling system that uses telecommunications between the train and the track equipment to keep trains at a safe separation, manage train traffic, and ensure compliance with track speed limits. With CBTC, the exact position of the train is more accurately known than with traditional fixed-block signal systems. Within NYCT, CBTC has been introduced on the Canarsie Line (L train) and the Flushing Line (7 train).

Crossover is an interlocking between parallel tracks to enable trains to move from one track to the other. A Universal Crossover consists of an adjacent pair of crossovers (one behind the other), one with right hand turnout and one with left hand turnout. This enables a train traveling in either direction on either of the parallel tracks to cross to the parallel track. A Diamond Crossover provides the same crossover capabilities as a Universal Crossover but superimposes both the right hand turnout crossover overlay and intersects the left hand crossover to consume less linear track length than a Universal Crossover.

Deadhead train is a train that operates without passengers (out of service). Deadhead trains are typically used to move trains from yards to the start of service, to yards at the end of service, or to remove trains from service for scheduled or unscheduled reasons.

Fixed-block signal system is a signaling system that divides each track into different fixed-length blocks with a signal at the entrance to the block to govern whether it is safe to enter and occupy that block. This type of signaling system is the most prevalent type within the NYCT subway.

Gap train is a train that is on standby—positioned at key points in the system—ready to enter revenue service in the event of another train failure or due to a large gap in train service.

Line refers to the name of the infrastructure (e.g., Brighton Line).

Put-Ins refers to a non-revenue train entering revenue service.

Relaying trains is the repositioning and reversing of an out-of-service train from one subway track to another, usually to position it for another revenue trip.

Revenue train is a train that is in passenger service.

Route refers to the train services that operate over a line (e.g., B and Q trains operate over the Brighton Line).

Storage Yard is a place where trains are stored either during the middays and/or overnight hours.

Tail tracks are non-revenue (no passengers allowed) tracks where subway trains are either stored, or turned back.

Turnout is a special track installation used to allow trains to proceed straight ahead or to diverge to another track. #XX turnout is the classification of a turnout by the inclination of the rail crossing contained in the turnout. Higher turnout numbers correspond to lower crossing angles and hence higher permissible speeds over that turnout. For example, a #10 turnout will permit trains to operate at a faster speed than a #6 turnout. Higher turnout numbers also correspond to longer turnout footprint length. A #10 turnout occupies a longer footprint than a #6 turnout. An Equilateral (Y-shaped) Turnout connects a center track to adjacent tracks on either side; thus, a train on the center track could access either of the two adjacent tracks.

Turnout Tangential Geometry is a detailed design improvement to the geometry of the curved rails in a turnout switch that reduces the rate of change of lateral acceleration (aka jerk) as a train makes a diverging move on the turnout. This allows trains to diverge at higher speeds compared to a conventional turnout, without increasing passenger discomfort or the risk of derailment.

Appendix B – Construction Duration and Capital Cost Estimate